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ABSTRACT

In 1974, the Office of Demographic Studies, Gallaudet College, conducted a survey in which the teachers of 978 hearing-impaired students in special education programs across the United States rated the degree to which the speech of each student would be understood by the average person. These ratings were then analyzed for their relationships to other significant characteristics of the children in question. Among the findings were 1) that speech intelligibility does not improve with age, 2) that it declines as the severity of the hearing loss increases, 3) that higher speech intelligibility is generally related to greater degrees of hearing aid usage (which, however, is itself strongly related to degree of hearing loss), 4) that placement in a particular type of educational program doesn't produce better intelligibility than placement in some other program type, 5) that black students are substantially less intelligible than students from other ethnic backgrounds, and that family income level is related to speech intelligibility. (Tables are provided for all study data). (DLS)

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The Rated Speech Intelligibility of Hearing Impaired Children: Basic Relationships and a Detailed Analysis

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ABSTRACT

This study examines the speech intelligibility of hearing impaired children as rated by their classroom teachers and relates these ratings to characteristics of the children and to the type of educational programs they attend. Subjects for the study were a national sample of almost 1,000 hearing impaired children in all types of special educational programs in all parts of the United States. The first section of the paper examines basic relationships; the second presents a detailed analysis, taking program type and degree of hearing loss into account.

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OFFICE OF DEMOGRAPHIC STUDIES
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THE ANNUAL SURVEY OF HEARING IMPAIRED CHILDREN AND YOUTH
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As is true of all products of the Office of Demographic Studies, this paper represents the efforts of all members of the ODS staff. The analysis of data and the subsequent writing of a report for publication are merely the last steps. The authors therefore acknowledge their debt to all members of the ODS staff. We wish especially to thank Arthur Schildroth for his contribution to the preparation of this report.

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THE RATED SPEECH INTELLIGIBILITY OF HEARING IMPAIRED CHILDREN: BASIC RELATIONSHIPS

INTRODUCTION

One of the goals of special educational programs for hearing impaired children is to develop the ability of their students to speak in a manner which is intelligible to the average person. The importance of this skill is immediately apparent in view of the fact that the overwhelming majority of any population depends on the spoken word as the primary channel of communication with fellow human beings. The purpose of this study is to examine some data from a national sample of hearing impaired children in the United States in order to determine the extent to which these children are able to speak intelligibly.

METHOD

In the spring of 1974 the Office of Demographic Studies (ODS) at Gallaudet College conducted a national achievement test standardization program using a stratified cluster sample of approximately 10,000 hearing impaired children who were enrolled in special educational programs. In addition to the norming portion of this project, detailed studies of a number of questions were made on a random subsample of the standardization sample. The classroom teachers of the 1,362 children in this subsample were asked to report, among other information, their estimate of the degree to which the speech of each student would be understood by the average person unfamiliar with that individual child. Speech intelligibility ratings were obtained for 978 of the 997 children whose teachers responded to the survey. Overall response rate to the survey was, therefore, 73%; and the speech intelligibility question was answered by 98% of those who returned the survey forms. There were no important or systematic differences in other available data between children whose teachers responded to this survey and those whose teachers did not reply.

The response categories on the survey form provided for this question regarding speech intelligibility were:

(a) Very intelligible (similar to the speech of a hearing person of the same age);
(b) Intelligible (somewhat difficult to understand);
(c) Barely intelligible (can only understand after repetition and use of other cues);
(d) Not intelligible;
(e) Student would not ordinarily attempt to use speech.

The limitations of this procedure are quite apparent, and no claim is made regarding the usefulness of this "questionnaire-rating-by-teacher" for clinical or individual child study purposes. The purpose of the study was simply to establish broad national baseline information and to examine the relationships of rated speech intellgibility to other significant characteristics of the children in question. As the results below will indicate, the ratings were well distributed and showed significant relationships to other relevant variables.

RESULTS

Age. The children in the study sample ranged in age from 4 years to 23 years. The first question of interest is whether rated speech intelligibility improved with age, as might be hoped and expected. Table 1 indicates that this is not the case,

TABLE 1: SPEECH INTELLIGIBILITY RATINGS BY CHRONOLOGICAL AGE

Age in Years[a]	Speech Intelligibility Ratings: Very Intelligible		Intelligible		Barely Intelligible		Not Intelligible		Would Not Speak		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
≤7	18	9.7	66	35.5	34	18.3	36	19.4	32	17.2	186	100.0
8-11	67	17.8	100	26.6	83	22.1	88	23.4	38	10.1	376	100.0
12-15	37	15.1	69	28.2	58	23.7	49	20.0	32	13.1	245	100.0
≥16	28	16.6	52	30.8	39	23.1	27	16.0	23	13.6	169	100.0
All Categories	150	15.4	287	29.4	214	21.9	200	20.5	125	12.8	976	100.0

$X^2 = 19.146$, $df = 12$, $p > .05$ (non-significant)

[a]The age of two students was not available.

that in fact there were no overall differences among the age groups in speech intelligibility, particularly above the age of 7. The product-moment correlation between age and rated speech intelligibility (-.04) is not significantly different from zero. This finding is in accord with that of Babbini and Quigley (1970), who tested 163 students in six residential schools for the deaf each year from 1963 through 1967. They concluded that their subjects ". . . could speak no more intelligibly at the end of the study than they could at the beginning, regardless of the amount of training they received in between, if any." The present study does not imply that speech intelligibility can never be improved, given training of appropriate quality, duration, and intensity. It simply indicates overall results of current practice as reported to the ODS.

Age at Onset of the Hearing Loss. While the influence of postlingual onset of hearing loss may be both theoretically relevant and actually important in this regard, this factor is not amenable to statistical treatment here because 96.8% of this sample (and about 95% of the national population) have a known age at onset before the age of three.

Degree of Hearing Loss. The extent of the child's hearing loss bears a major relationship to the speech intelligibility rating received, as shown by Table 2. Rated speech intelligibility is uniformly high for the groups of students with less than 70 dB loss; more than 80% of these students are rated as speaking intelligibly or very intelligibly. Beyond the 70 dB point, there appears to be an abrupt downward shift in intelligibility ratings. From another perspective, the correlation coefficient between intelligibility ratings and degree of loss is -.68, which again emphasizes that intelligibility declines as the severity of the loss increases. (The second section of this paper addresses this variable in more detail.)

TABLE 2: SPEECH INTELLIGIBILITY RATINGS BY DEGREE OF HEARING LOSS

	Speech Intelligibility Ratings											
	Very Intelligible		*Intelligible*		*Barely Intelligible*		*Not Intelligible*		*Would Not Speak*		*Total*	
Degree of Hearing Loss[a]	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
<27dB ISO	6	60.0	3	30.0	1	10.0	0	0	0	0	10	100.0
27-40dB ISO	10	43.5	10	43.5	2	8.7	1	4.3	0	0	23	100.0
41-55dB ISO	31	52.5	22	37.3	6	10.2	0	0	0	0	59	100.0
56-70dB ISO	40	38.8	46	44.7	9	8.7	5	4.9	3	2.9	103	100.0
71-90dB ISO	41	15.6	103	39.3	53	20.2	35	13.4	30	11.5	262	100.0
≥91dB ISO	15	3.1	96	20.0	135	28.2	149	31.1	84	17.5	479	100.0
All Categories	143	15.3	280	29.9	206	22.0	190	20.3	117	12.5	936	100.0

$X^2 = 310.7$, $df = 20$, $p < .001$

[a] Estimates of hearing loss were not available for 42 students.

Use of Hearing Aids. The relationship of hearing aid usage, in three different situations, with rated intelligibility of speech is shown in Table 3. Higher speech intelligibility is generally related to greater degrees of hearing aid usage. It is important to point out, however, that usage of hearing aids is strongly related to degree of hearing loss (see Karchmer & Kirwin, 1977), so that the information in Table 3 is much the same information as that presented in Table 2. Since these data are correlational in nature, it cannot be argued from Table 3 that greater usage of hearing aids, in itself, produces greater intelligibility of speech, especially in view of the strong relationship of aid usage to degree of hearing loss. What is clear is that less severe loss, greater usage of hearing aids, and more intelligible speech generally occur together.

Type of Educational Program. Intelligibility rating differences for children in various types of educational placements are shown in Table 4. These figures are presented for informational purposes, but most assuredly do not document differences which are causal in nature; that is, as with Table 3, it cannot be argued from these data that placement in some particular type of program produces better intelligibility than placement in some other program type. This is so for at least two sets of reasons: (1) as shown by Karchmer and Trybus (1977) and by Jensema (1974), there are significant differences among children in different educational settings on a number of educationally critical dimensions, including degree of loss, age, and family income levels; and (2) speech intelligibility itself (together with its concomitant, less severe hearing loss) is sometimes used as one criterion for selecting students for placements in integrated settings. (Further analyses of the relationship of educational setting to intelligibility are contained in the second section of this paper.)

TABLE 3: SPEECH INTELLIGIBILITY RATINGS BY HEARING AID USAGE IN THREE SITUATIONS

Hearing Aid Use Situation	Degree of Use	Speech Intelligibility Ratings: Very Intelligible		Intelligible		Barely Intelligible		Not Intelligible		Would Not Speak		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
Used in Class[1]	1) No	20	10.3	21	10.8	45	23.1	65	33.5	43	22.2	194	100.0
	2) Yes	129	16.7	264	34.2	165	21.4	131	17.0	82	10.6	771	100.0
Used Out of Class But in School[2]	1) Never	30	10.8	36	12.9	67	24.0	91	32.6	55	19.7	279	100.0
	2) Sometimes	4	4.7	26	30.6	24	28.2	23	27.1	8	9.4	85	100.0
	3) Usually	8	6.8	39	33.1	33	28.0	22	18.6	16	13.6	118	100.0
	4) Always	104	22.9	179	39.3	85	18.7	53	11.6	34	7.5	455	100.0
Used at Home or in the Dormitory[3]	1) Never	24	8.8	31	11.3	70	25.5	94	34.3	55	20.1	274	100.0
	2) Sometimes	10	7.4	39	28.9	36	26.7	36	26.7	14	10.4	135	100.0
	3) Usually	22	13.3	61	36.7	38	22.9	29	17.5	16	9.6	166	100.0
	4) Always	83	26.3	136	43.0	56	17.7	23	7.3	18	5.7	316	100.0

[1] $\chi^2 = 69.9$, $df = 4$, $p < .001$
[2] $\chi^2 = 141.1$, $df = 12$, $p < .001$
[3] $\chi^2 = 178.6$, $df = 12$, $p < .001$

TABLE 4: SPEECH INTELLIGIBILITY RATINGS BY TYPE OF EDUCATIONAL PROGRAM

Program Type[a]	Speech Intelligibility Ratings: Very Intelligible		Intelligible		Barely Intelligible		Not Intelligible		Would Not Speak		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Residential School for the Deaf	31	7.5	96	23.4	101	24.6	119	29.0	64	15.6	411	100.0
Day School for the Deaf	15	10.3	47	32.4	32	22.1	29	20.0	22	15.2	145	100.0
Full-Time Special Education Classes	52	18.6	94	33.7	56	20.1	48	17.2	29	10.4	279	100.0
Part-Time Special Education Classes	17	30.9	16	29.1	16	29.1	3	5.5	3	5.5	55	100.0
Itinerant Program	22	51.2	17	39.5	3	7.0	0	0	1	2.3	43	100.0
Other	13	30.2	17	39.5	6	14.0	1	2.3	6	14.0	43	100.0
All Program Types	150	15.4	287	29.4	214	21.9	200	20.5	125	12.8	976	100.0

$\chi^2 = 138.4$, $df = 20$, $p < .001$
[a] Program type was not available for two students.

Student Ethnic Background. There are significant differences in the rated intelligibility of hearing impaired children according to their ethnic background, as is documented in Table 5. In particular, black students are rated as substantially less intelligible (21% rated as "intelligible" or "very intelligible") than students from other backgrounds (40% to 50% reported with "intelligible" or "very intelligible" speech). At least two considerations are important in reviewing these

data. While figures are not available, it is very likely that the large majority of the teachers doing the ratings are from other than black ethnic groups, and intelligibility is in the ear of the listener as well as in the mouth of the speaker. Second, there is evidence (Jensema & Trybus, in press) that teachers of hearing impaired children use less speech in class with black students than with others, so that differences may lie in educational practices as well as in the rated outcomes of those practices.

Family Income Level. Table 6 shows that family income level is related to the rated speech intelligibility of hearing impaired children, just as it is related to many other educational outcomes, both for hearing and for deaf children (see Rawlings & Jensema, 1977). The differences among economic groups are most pronounced in the "would not speak" category, suggesting that cultural mores and motivations may be involved as well as differential ability levels. In any case, children from higher income families generally show greater willingness to speak and more intelligible results when they do speak.

TABLE 5: SPEECH INTELLIGIBILITY RATINGS BY ETHNIC BACKGROUND

	Speech Intelligibility Ratings											
	Very Intelligible		*Intelligible*		*Barely Intelligible*		*Not Intelligible*		*Would Not Speak*		*Total*	
Ethnic Background[a]	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
White	118	18.5	208	32.6	137	21.4	110	17.2	66	10.3	639	100.0
Black	6	3.7	28	17.4	42	26.1	47	29.2	38	23.6	161	100.0
Spanish-American	18	14.4	32	25.6	26	20.8	31	24.8	18	14.4	125	100.0
Other	1	11.1	3	33.3	0	0	4	44.4	1	11.1	9	100.0
All Categories	143	15.3	271	29.0	205	21.9	192	20.6	123	13.2	934	100.0

$\chi^2 = 62.9$, $df = 12$, $p < .001$

[a]Ethnic background was not available for 44 students.

TABLE 6: SPEECH INTELLIGIBILITY RATINGS BY FAMILY INCOME

	Speech Intelligibility Ratings											
	Very Intelligible		*Intelligible*		*Barely Intelligible*		*Not Intelligible*		*Would Not Speak*		*Total*	
Annual Family Income	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
<$5,000	6	5.0	28	23.1	34	28.1	26	21.5	27	22.3	121	100.0
$5,000-$9,999	19	11.8	40	24.8	37	23.0	44	27.3	21	13.0	161	100.0
$10,000-$14,999	37	19.9	58	31.2	43	23.1	29	15.6	19	10.2	186	100.0
$15,000-$19,999	18	23.1	32	41.0	9	11.5	10	12.8	9	11.5	78	100.0
≥ $20,000	17	26.2	17	26.2	13	20.0	15	23.1	3	4.6	65	100.0
All Categories	97	15.9	175	28.6	136	22.2	124	20.3	79	12.9	611	100.0

$\chi^2 = 53.8$, $df = 16$, $p < .001$

Communication Methods Used in School. The extent to which the communication methods used by the hearing impaired child are related to rated speech intelligibility is shown in Table 7, which gives a series of correlation coefficients between speech intelligibility ratings and frequency-of-use ratings for five methods of communication in six different communication situations, along with the number of cases upon which each coefficient is based (the *N*'s are not equal as a result of differential amounts of missing data in the reporting of frequency of use of each method in each situation). The ratings of frequency of use of each communication method were made by the same teacher who made the speech intelligibility rating for each child. Each rating was made on a four-point scale ("always," "usually," "sometimes," "never"), and each rating was independent of every other rating. In other words, an "always" rating on speech might be accompanied by "always," "usually," "sometimes," or "never" on the signs-with-fingerspelling item; the choice was not an either/or selection of methods, but a rating of the extent to which each method was used with the student. The data indicate that children with high intelligibility ratings also use speech frequently; as their use of signs-with-fingerspelling declines, the more intelligible their speech. As with all data in this report, the relationships are correlational in nature, and causal conclusions cannot be drawn legitimately on the basis of these data alone. The point is that different communication patterns are associated with different levels of rated speech intelligibility as well as with clusters of other variables, such as degree of hearing loss.

TABLE 7: CORRELATIONS BETWEEN SPEECH INTELLIGIBILITY RATINGS AND REPORTED FREQUENCY OF USE OF VARIOUS COMMUNICATION METHODS

	Communication Method									
	Speech		*Signs-with-Finger-spelling*		*Finger-spelling*		*Gestures*		*Writing*	
Communication Situation	*r**	*N*	*r**	*N*	*r**	*N*	*r**	*N*	*r**	*N*
Student to Teacher	.68	908	—.43	892	—.26	817	—.35	886	—.06	822
Student to Deaf Student	.64	871	—.34	895	—.20	806	—.28	881	.04	798
Student to Hearing Student	.71	708	—.38	624	—.27	599	—.43	688	—.18	626
Teacher to Student	.34	913	—.37	872	—.25	811	—.27	866	—.07	840
Deaf Student to Student	.50	846	—.33	878	—.19	786	—.22	859	.05	775
Hearing Student to Student	.51	668	—.29	585	—.20	565	—.36	644	—.20	584

*For N = 500, correlations of ± .09 or greater are significant at the .05 level.
For N = 1000, correlations of ± .06 or greater are significant at the .05 level.

Much of the variance in the speech intelligibility represented by the correlations in Table 7 is overlapping, as can be demonstrated by means of a multiple regression analysis. A multiple *R* of .79 was obtained, indicating that 63% of the variance is held in common with a linear combination of the 30 variables in Table 7. Since the highest single correlation (.71) accounts for more than 50% of the variance, the addition of the other 29 variables adds only 13% to the total variance held in common.

Other Multiple Regression Analyses. Further examinations of the speech intelligibility data were undertaken by means of additional multiple regression analyses. The first of these involved predicting speech intelligibility ratings from a linear combination of the demographic variables considered earlier in this paper. Two categorical variables, ethnic background and type of educational program, were converted to "dummy" variables by recoding ethnic background as "white" and "non-white," and by assigning rank values to the program types in the order in which they are listed in Table 4. (The values reflect a rough ordering of the relative amount of special services provided by the program type.) The result was a multiple *R* value of .64, meaning that the demographic variables can account for about 41% of the speech intelligibility variance.

Finally, a multiple regression analysis was conducted using the 30 communication method variables along with the demographic variables to predict speech intelligibility ratings. This procedure yielded a multiple *R* of .82, indicating that 67% of the variance in the speech intelligibility ratings was accounted for. Three variables (frequency of speech usage in deaf-student-to-hearing-student communication, degree of hearing loss, and hearing aid use at home or in a dormitory) accounted for 58% of the speech intelligibility variance.

In summary, speech intelligibility appears to be related primarily to the extent and quality of auditory input as reflected by the degree of hearing loss, usage of hearing aids, and the frequency of speech communication.

THE RATED SPEECH INTELLIGIBILITY OF HEARING IMPAIRED CHILDREN: DETAILED ANALYSIS BY DEGREE OF LOSS AND TYPE OF EDUCATIONAL PROGRAM *

INTRODUCTION AND METHOD OF ANALYSIS

This section of the paper examines in greater detail the speech intelligibility data which were analyzed in the first part of this publication in terms of basic relationships. In particular, speech intelligibility ratings will be examined in terms of their relationships to the degree of hearing loss and the type of educational placement of the hearing impaired children involved.

This analysis is made necessary by the fact, documented by Karchmer and Trybus (1977) and by Jensema (1974), that there are substantial and systematic differences in the degree of hearing loss of children enrolled in various types of special educational programs (as well as other significant differences). Specifically, residential schools for the deaf and day schools for the deaf serve a population who are mostly profoundly deaf (63% of residential school students nationally have hearing losses of 91dB or more in the better ear), whereas integrated programs in local school districts enroll only a small proportion (18%) of profoundly deaf children and a majority (62%) with mild-to-moderate losses. Therefore, program-to-program comparisons of speech intelligibility ratings are reflecting mostly these large differences in the populations served, as was pointed out in the first section.

This analysis will also use a somewhat different classification of the types of educational programs from that used in the first section, one which is based on preliminary analyses of these data and which takes into consideration that the classification should not result in a category with so few cases that further meaningful subgroupings become impossible. First of all, the students in residential schools for the deaf will be treated here as two groups: (a) those who actually live at the school, and (b) those who attend classes at the school but do not actually live on the campus. As the analyses will show, these two groups perform quite differently on rated speech intelligibility. The other difference in classification is that all students who receive only part-time special education services are grouped together (i.e., they are at least partially "integrated" or "mainstreamed") in order to increase the size of this group for purposes of further analysis.

As was the case in the previous section, the age at onset of the hearing loss was not entered into the analysis simply because so few children now in special education have postlingual onsets; further comparative analysis therefore would yield no generally useful information. While the age at which the child entered school might be assumed to be a significant factor in later speech intelligibility, preliminary analysis indicated that, at least for this sample, there were no significant differences in speech intelligibility ratings for those children who had some preschool experience compared to those who had not received such services. This factor has been found to be important in analyses of other variables such as achievement test scores (see Ries, 1973). However, as no differences were found in this case, there was no compelling reason to control for this variable or include it in the analysis.

Finally, in order to preserve subgroups large enough for meaningful analysis, the degree of hearing loss was regrouped from the six categores described earlier to three: (1) profound losses, 91 dB or more in the better ear; (2) severe losses, between 71 and 90 dB in the better ear; and (3) less than severe losses, 70 dB or less in the better ear. The students with losses of 70 dB and under were combined into a single category because, as the first section makes clear, rated intelligibility does not change appreciably across this range. Thus, a group of children with losses of 40 dB, for example, is not, in speech intelligibility terms, statistically different from a group with 65 dB losses.

RESULTS

Overall findings. Table 1 describes the distribution of students in the sample by program type and degree of hearing loss; this table in itself is the first finding of the study and indicates the relationship between degree of hearing loss and educational placement. Clearly, residential schools enroll mostly profoundly deaf children (65% of their total enrollment), whereas integrated programs enroll only a small portion (19%) of children with profound losses. This finding colors all subsequent results and, in fact, dictates the shape of the remaining analyses of the data.

* The authors wish to acknowledge their thanks to Dr. Winifred Northcott, whose suggestions and inquiries led to the development of these analyses and the resulting section of this report.

TABLE 1: DISTRIBUTION OF SAMPLE BY PROGRAM TYPE AND DEGREE OF HEARING LOSS

Type of Program	Less than Severe(≤70dB)		Severe (71-90 dB)		Profound (≥ 91 dB)		Total	
	N	%	N	%	N	%	N	%
Residential School, Residential Students	24	7.2	93	27.5	220	65.3	337	100.0
Residential School, Day Students	5	7.4	18	26.4	45	66.2	68	100.0
Day School	23	16.1	35	24.5	85	59.4	143	100.0
Full-Time Classes	73	26.7	85	31.1	115	42.1	273	100.0
All Part-Time Services	71	57.3	30	24.2	23	18.5	124	100.0
Total	196	20.7	261	27.6	488	51.6	945	100.0

TABLE 2: PERCENTAGE OF STUDENTS WITH INTELLIGIBLE OR VERY INTELLIGIBLE SPEECH BY PROGRAM TYPE AND DEGREE OF HEARING LOSS

Type of Program	Less than Severe (≤ 70 dB)	Severe (71-90 dB)	Profound (≥ 91 dB)	Average by Program Type
Residential School, Residential Students	66.6%	45.2%	17.3%	28.5%
Residential School, Day Students	80.0%	66.7%	31.1%	44.1%
Day School	91.3%	54.3%	25.9%	43.4%
Full-Time Classes	84.9%	62.4%	23.5%	52.0%
All Part-Time Services	89.9%	56.6%	39.1%	74.2%
Average by Hearing Loss	86.2%	54.8%	22.5%	

Table 2 shows the percentage of each subgroup who were rated by teachers as speaking "intelligibly" or "very intelligibly." The figures in each cell of Table 2 are based upon the corresponding *N*'s in Table 1. Thus, for example, the entry in the first row of the column of Table 2 reads "66.6%." This indicates that this percentage of the number of children in the corresponding cell of Table 1 (i.e., 24) speaks intelligibly, that is, 16 students out of the 24 in this cell. Examination of this table, and especially of the averages by degree of loss and by program type, shows that intelligibility decreases markedly as the hearing loss becomes more severe, for all types of special education programs.

The results of analysis of variance of the intelligibility ratings by degree of loss and program type are presented in Table 3. It is clear that each variable considered separately, as well as the two variables taken together, have significant ($p < .001$) effects on the intelligibility ratings. A more important consideration is the size or magnitude of these effects, and from this perspective it is clear that the degree of hearing loss is a far more important variable than program type, since it accounts for more than eight times as much variance as does program type. Overall, program type accounts for 2.2% of the speech intelligibility variance, while degree of hearing loss accounts for 18% of the total variance. Since these

two variables are themselves correlated, the combined effect of the two variables together accounts for 28.9% of the total variance, a good bit more than the simple sum of the separate effects. In view of the close interrelatedness of program type and degree of hearing loss, the remainder of the analyses will concentrate, in turn, on each of the three subgroups delineated in terms of degree of hearing loss (i.e., profound, severe, and less-than-severe).

Children with less-than-severe losses. The distribution of speech intelligibility ratings for children with less-than-severe losses in each of the program types is presented in Table 4. An important feature of the table is the small number of children in residential and day schools within this range of hearing loss. As indicated, the differences across program types are not significant. In all program types the large majority of children with losses in this range speak intelligibly. A further examination of these data is presented in Table 5, which shows the results of a one-way analysis of variance across program types. As indicated, this test *did* show significant differences among program types, but two further considerations are relevant. First, the variance accounted for by program differences was very limited, amounting to 6% of the total variance. Second, there are different distributions of hearing loss among the program types, even within this restricted range. In particular, the proportion of children whose loss is within the upper end of the range (56-70 dB, the "moderately severe" losses) is 88% for residential students in residential schools, 80% for day students in residential schools, 61% for students in day schools, 56% for children in full-time classes in local school districts, and 34% for children receiving part-time services in local school districts. It is clear, therefore, that the differences which do exist are again directly related to differences in the degree of hearing loss; if this is taken into consideration, there are no significant differences in intelligibility across program types for children with less-than-severe losses.

TABLE 3: ANALYSIS OF VARIANCE OF SPEECH INTELLIGIBILITY RATINGS

Source of Variation	*Sum of Squares*	*df*	*Mean Square*	*F*	
Main Effects Together	432.93	6	72.16	63.47	$p < .001$
Degree of Loss	269.62	2	134.81	118.59	$p < .001$
Program Type	32.96	4	8.24	7.25	$p < .001$
Interaction, Degree of Loss by Program Type	5.44	8	0.68	0.60	n.s.
Residual	1057.20	930	1.14		
Total	1495.57	944	1.58		

TABLE 4: SPEECH INTELLIGIBILITY RATINGS BY PROGRAM TYPE (CHILDREN WITH LOSSES ≤ 70 dB IN THE BETTER EAR)

Speech Intelligibility Ratings	*Residential School, Residential Students*		*Residential School, Day Students*		*Day School*		*Full-Time Special Education*		*All Part-Time Special Education*	
	%	N	%	N	%	N	%	N	%	N
Very Intelligble	33.3	8	20.0	1	26.1	6	45.2	33	54.9	39
Intelligible	33.3	8	60.0	3	65.2	15	39.7	29	38.0	27
Barely Intelligible	20.8	5	20.0	1	4.3	1	8.2	6	7.0	5
Not Intelligible	8.3	2	0	0	4.3	1	4.1	3	0	0
Would Not Speak	4.2	1	0	0	0	0	2.7	2	0	0
Total	100.0	24	100.0	5	100.0	23	100.0	73	100.0	71

$X^2 = 22.38$, $df = 16$, non-significant

TABLE 5: ANALYSIS OF VARIANCE OF SPEECH INTELLIGIBILITY RATINGS FOR 5 PROGRAM TYPES (LOSSES OF ≤70dB IN BETTER EAR)

Source	*Sum of Squares*	*df*	*Mean Square*	*F*
Between Groups	8.67	4	2.17	3.05*
Within Groups	135.58	191	0.71	
Total	144.25	195		

*$p < .02$

TABLE 6: SPEECH INTELLIGIBILITY RATINGS BY PROGRAM TYPE (LOSSES OF 71-90 dB IN BETTER EAR)

Speech Intelligibility Ratings	*Residential School, Residential Students*		*Residential School, Day Students*		*Day School*		*Full-Time Special Education*		*All Part-Time Special Education*	
	%	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*
Very Intelligible	12.9	12	16.7	3	14.3	5	15.3	13	23.3	7
Intelligible	32.3	30	50.0	9	40.0	14	47.1	40	33.3	10
Barely Intelligible	19.4	18	22.2	4	28.6	10	16.5	14	23.3	7
Not Intelligible	21.5	20	5.6	1	8.6	3	12.9	11	6.7	2
Would Not Speak	14.0	13	5.6	1	8.6	3	8.2	7	13.3	4
Total	100.0	93	100.0	18	100.0	35	100.0	85	100.0	30

$\chi^2 = 15.65$, *df* = 16, non-significant

TABLE 7: ANALYSIS OF VARIANCE OF SPEECH INTELLIGIBILITY RATINGS FOR 5 PROGRAM TYPES (LOSSES BETWEEN 71-90 dB IN BETTER EAR)

Source	*Sum of Squares*	*df*	*Mean Square*	*F*
Between Groups	10.39	4	2.60	1.80*
Within Groups	370.57	256	1.45	
Total	380.97	260		

*Non-significant

Children with severe losses. The results for children with better ear losses in the severe range (71-90 dB) are presented in Tables 6 and 7. Both the chi-square analysis and the one-way analysis of variance of the speech intelligibility ratings show no significant differences among the five program settings for children with losses in this range of severity.

Children with profound losses. Comparable analyses for children with losses in the profound range (91 dB or more in the better ear) are presented in Tables 8 and 9. It is clear that in this range there are significant differences in rated intelligibility across program types, as attested to both by the chi-square analysis in Table 8 and by the one-way analysis of variance in Table 9. Differences can be seen in almost all the rating categories, with an overall result that children in integrated programs are rated as more intelligible and residential students at residental schools as less intelligible than children in the other special school or special class situations. Again, however, it is important to note that the proportion of speech intelligibility variance accounted for by differences in program type is very small, 3.4% of the total variance. In other words, while the differences among program types are statistically significant, they have little practical meaning. Further, these differences among program types cannot be interpreted as causal from these data; one cannot conclude that the children in integrated programs are more intelligible *because* they are in integrated programs rather than in special schools or classes. It is, of course, possible that this is the case; but it is also possible that children are selected for enrollment in integrated programs, at least in part, precisely because their speech is reasonably intelligible and will therefore permit them to integrate more easily than other children whose speech is less intelligible. The earlier finding in this report that rated speech intelligibility does not increase with age would tend to support the latter interpretation, i.e., that preexisting differences lead to differential educational placements rather than differences being produced by enrollment in a particular program type.

TABLE 8: SPEECH INTELLIGIBILITY RATINGS BY PROGRAM TYPE (LOSSES OF ≥ 91 dB IN BETTER EAR)

Speech Intelligibility Ratings	*Residential School, Residential Students*		*Residential School, Day Students*		*Day School*		*Full-Time Special Education*		*All Part-Time Special Education*	
	%	N	%	N	%	N	%	N	%	N
Very Intelligible	2.3	5	4.4	2	4.7	4	3.5	4	0	0
Intelligible	15.0	33	26.7	12	21.2	18	20.0	23	39.1	9
Barely Intelligible	26.4	58	31.1	14	23.5	20	29.6	34	47.8	11
Not Intelligible	36.4	80	31.1	14	29.4	25	29.6	34	8.7	2
Would Not Speak	20.0	44	6.7	3	21.2	18	17.4	20	4.3	1
Total	100.0	220	100.0	45	100.0	85	100.0	115	100.0	23

$\chi^2 = 27.03$, $df = 16$, $p < .05$

TABLE 9: ANALYSIS OF VARIANCE OF SPEECH INTELLIGIBILITY RATINGS FOR 5 PROGRAM TYPES (LOSSES OF ≥ 91 dB IN BETTER EAR)

Source	*Sum of Squares*	*df*	*Mean Square*	*F*	
Between Groups	19.34	4	4.84	4.24*	p < .002
Within Groups	551.04	483	1.14		
Total	570.38	487			

*Non-significant

SUMMARY AND CONCLUSIONS

In general, this detailed analysis of speech intelligibility ratings, which considers both the child's educational placement and degree of hearing loss, has shown that speech intelligibility is more strongly related to the degree of hearing loss than to the student's educational program. The relationship of intelligibility to educational program type, when differences in degree of loss are taken into account, is not significant for children with losses up to 90 dB; it is statistically significant, but of minimal practical importance, for children with losses of 91 dB and more.

An unexpected and interesting finding is that children who attend residential schools on a day basis are, in speech intelligibility terms, quite different from residential students at residential schools. Other ODS data, as yet unpublished, suggest that similar differences exist between these two groups on a number of other educationally significant variables. This is certainly a question deserving of further investigation.

This report, like almost all publications produced by the Office of Demographic Studies, has concentrated on a description of important factors involved in the education of hearing impaired children and on an analysis of interrelationships among those factors. Thus, the report describes what, in the light of the ODS data, the general situation across the country currently is, not what could or should be and not what is the case in one or a few particular programs. There are, no doubt, many special educational programs which do succeed in improving the intelligibility of their students' speech over the course of their school years; and there may be programs in which high levels of intelligibility are achieved for various students, despite large differences in their degrees of hearing loss. This report makes no claim that such situations do not or cannot exist. It is simply an attempt to describe ODS data on speech intelligibility and to analyze, on a nationwide basis, its relationship to several other educational factors.

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